UNDERSTANDING CAM PROFILE TERMS

RAMPS The parts of a camshaft lobe that actually initiate the lifting and descending movement of the lifter are called "ramps". Ramps include the lash ramp, the opening ramp, and the closing ramp. Camshaft lobe ramps are ground to have different rates of lifter movement in terms of velocity and degrees of duration, as measured in degrees of crankshaft rotation.

The "lash ramp" of a camshaft lobe is a mid-point location between the opening ramp and closing ramp.
The "opening ramp" of a camshaft lobe is the point where the lifter just begins to lift until the point that it reaches the nose of the lobe

The "closing ramp" is the point of the camshaft lobe from the nose back down to the lash ramp

NOSE The "nose" of a camshaft lobe is the top or the highest maximum lift point for the valve. It is where valves are kept open for as long as possible before making the transition to the closing ramp.

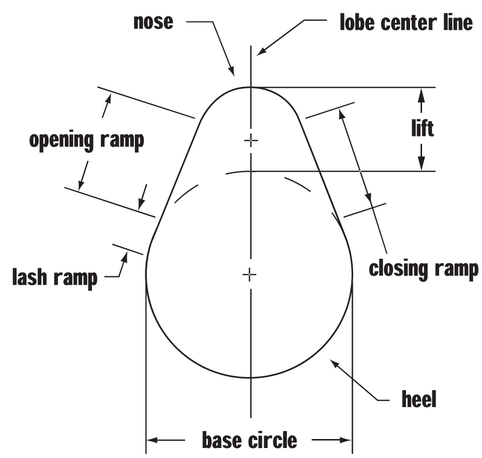
BASE CIRCLE The "base circle", also known as the "heel", is the lowest point of the camshaft lobe and is the place where the valve is in the closed position. The "base circle" is the point where all valve lash settings are made.

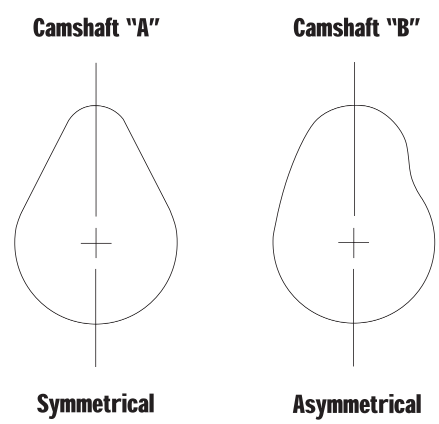
SYMMETRICAL is a term that refers to the "profiles" of the opening and closing ramps of a camshaft lobe. All "early technology" camshafts were ground on a symmetrical design, meaning both sides are exactly the same. That is to say the profile of the closing ramp is a "mirror image" of the opening ramp.

ASYMMETRICAL refers to a camshaft lobe profile where the opening and closing ramps are not exactly the same. The reason some camshafts are this way is to try to achieve an opening ramp profile that has a high velocity and a closing ramp profile that has a slower velocity. In this way the valve can be set down more "gently" than the rate at which it was first opened.

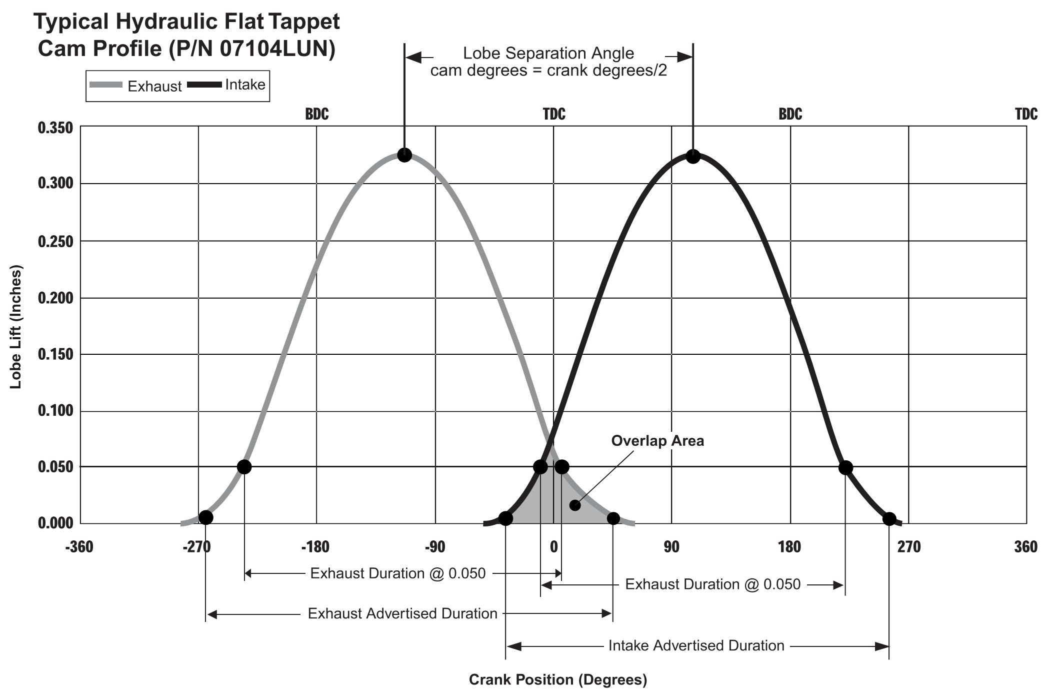
A DUAL PATTERN camshaft has an intake lobe profile design that differs from that of the exhaust lobe profile design. For example, camshaft "A" has intake lobes of 260º duration while the exhaust lobes are 270ºduration. Camshaft "B", has intake and exhaust lobes that are both at 260º. Camshaft "A" is referred to as a dual pattern, while camshaft "B" is referred to as a single pattern.

With the advent of emissions laws and the widespread use of computer systems, more modern single and dual profile pattern designs have been developed. A dual pattern camshaft is ground to "bias" the duration of either the intake or exhaust lobe. For example, if an engine is restricted on the exhaust side, compared to the intake side, the camshaft designer would try to compensate by grinding in more lift and/or duration on the exhaust lobe.





UNDERSTANDING CAMSHAFT SPECIFICATIONS



PISTON POSITION

The following table defines the abbreviations that are used to describe the location of the piston relative to either the bottom or top of its stroke:

TDC	Top dead center
BDC	Bottom dead center
ATDC	After top dead center
BTDC	Before top dead center
ABDC	After bottom dead center
BBDC	Before bottom dead center

LIFT

Lift refers to maximum valve lift. This is how much the valve is "lifted" off its seat at the cam lobe's highest point.

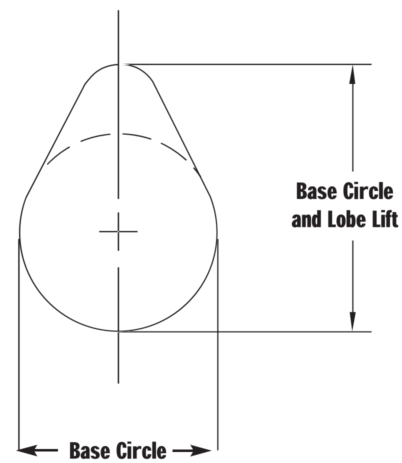
How is it measured?

Valve Lift is the amount (usually in inches) that the valve is lifted off of its seat. It is usually measured with a dial indicator at the tip of the valve. Lobe Lift is the amount (usually in inches) that the cam lobe increases in radius above the cam base circle.

Tip: To quickly find maximum lobe lift, measure the base circle of the cam and subtract it from the thickness across the cam lobe's highest point (see the diagram below).

Tip: Maximum valve lift can be calculated by multiplying the maximum lobe lift times the rocker ratio. For example, a 0.310" lobe lift cam yields 0.496" of valve lift when using a 1.6 ratio rocker arm.

Formula: valve lift = lobe lift x rocker ratio



Lobe Lift = Base Circle and Lobe Lift - Base Circle

What does it do?

The intake and exhaust valves need to open to let air/fuel in and exhaust out of the cylinders. Generally, opening the valves quicker and further will increase engine output. ***Increasing*** valve lift, without increasing duration, can yield more power without much change to the nature of the power curve. However, an increase in valve lift almost always is accompanied by an increase in duration. This is because ramps are limited in their shape which is directly related to the type of lifters being used, such as flat or roller.

DURATION

Duration is the angle in crankshaft degrees that the valve stays off its seat during the lifting cycle of the cam lobe.

How is it measured?

Advertised duration is the angle in crankshaft degrees that the cam follower is lifted more than a pre-determined amount (the SAE standard is 0.006") off of its seat. ***Duration @.050"*** is a measurement of the movement the cam follower, in crankshaft degrees, from the point where it's first lifted .050" off the base circle on the opening ramp side of the camshaft lobe, to the point where it ends up being .050" from the base circle on the closing ramp side of the camshaft lobe. This is the industry standard, and is a good value to use to compare cams from different manufacturers. Both are usually measured with a dial indicator and a degree wheel.

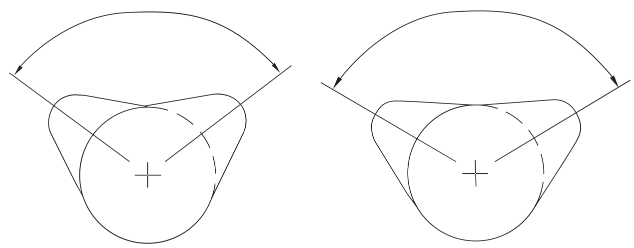
What does it do?

Increasing duration keeps the valve open longer, and can increase high-rpm power. Doing so increases the RPM range that the engine produces power. ***Increasing*** duration without a change in lobe separation angle will result in increased valve overlap.

UNDERSTANDING CAMSHAFT SPECIFICATIONS

LOBE SEPARATION

Lobe separation is the angle in camshaft degrees between the maximum lift points of the intake and exhaust valves. It is the result of the placement of the intake and exhaust lobes on the camshaft.



lobe separation = (intake centerline + exhaust centerline)/2

How is it measured?

Lobe separation can be measured using a dial indicator and a degree wheel, but is usually calculated by dividing the sum of the intake centerline and the exhaust centerline by two.

What does it do?

Lobe separation affects valve overlap, which affects the nature of the power curve, idle quality, idle vacuum, etc.

OVERLAP

Overlap is the angle in crankshaft degrees that both the intake and exhaust valves are open. This occurs at the end of the exhaust stroke and the beginning of the intake stroke. Increasing lift duration and/or decreasing lobe separation increases overlap.

How is it measured?

Overlap can be calculated by adding the exhaust closing and the intake opening points. For example, a cam with an exhaust closing at 4° ATDC and an intake opening of 8° BTDC has 12° of overlap.

But keep in mind that since these timing figures are at 0.050″ of valve lift, this therefore is overlap at 0.050.″ A better way to think about overlap is the area that both lift curves overlap, rather than just the crankshaft angle that both valves are open. Therefore, one can see that decreasing the lobe separation only a few degrees can have a huge effect on overlap area.

What does it do?

At high engine speeds, overlap allows the rush of exhaust gasses out the exhaust valve to help pull the fresh air/fuel mixture into the cylinder through the intake valve. Increased engine speed enhances the effect. ***Increasing*** overlap increases top-end power and reduces low-speed power and idle quality.

CENTERLINES

The intake centerline is the point of highest lift on the intake lobe. It is expressed in crankshaft degrees after top dead center (ATDC). Likewise the exhaust centerline is the point of highest lift on the exhaust lobe. . It is expressed in crankshaft degrees before top dead center (BTDC). The cam centerline is the point halfway between the intake and exhaust centerlines.

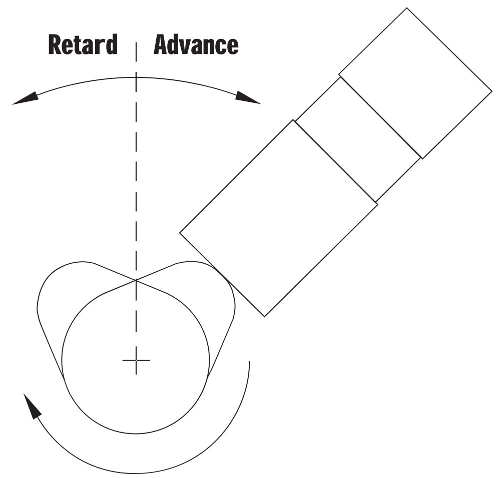
ADVANCE/RETARD

Advancing or retarding the camshaft moves the engine's torque band around the RPM scale by moving the valve events further ahead or behind the movement of the piston. Typically, a racer will experiment with advancing or retarding a cam from "straight up" and see what works best for their application. Lunati camshafts are ground to provide maximum performance and are designed to be installed to the specifications listed on the cam card.

How is it measured?

A cam with a 107° intake lobe centerline will actually be centered at 103° ATDC when installed 4° advanced.

Most Lunati camshafts have a certain amount of advance "ground in. "Ground-in advance" can also be found by subtracting the intake lobe centerline from the lobe separation.



What does it do?

Advance improves low-end power and response. For a general summary of the affects of camshaft timing, refer to the following table:

Advance

begins intake event sooner
opens intake valve sooner
builds more low-end torque
decreases piston-to-intake-valve clearance
increases piston-to-exhaust-valve clearance

Retard

delays intake event
opens intake valve later
builds more high-end power
increases piston-to-intake-valve clearance
decreases piston-to-exhaust-valve clearance

UNDERSTANDING VALVE TRAIN COMPONENTS

LIFTER

The cam lifter (also called a "follower" or "tappet") is the component that makes direct contact with the cam lobes and "follows" the profile of the cam. There are generally four types of lifters:

Hydraulic Flat Tappet

The hydraulic flat tappet is self-adjusting, due to the valve controlled plunger within the tappet body. It operates to pre-load the push-rod by using the oil system pressure to maintain this pre-load in the closed valve position. Hydraulic tappets are quieter than mechanical tappet lifters since there is no lash or free-play. However, it is generally agreed that they fall short of offering optimum performance above 6,000 - 6,500 RPM. Many cheaper designs fall even shorter than this. This poor performance at high RPM is due mainly to the inability of the lifter to "bleed down" the excessive oil pressure , and thus does not allow the valves to seat.

Mechanical Flat Tappet

The mechanical (solid) tappet is essentially a solid "link" between the cam lobe, and the push-rod. In most cases it is a simple heat-treated cylinder with a radiused contact face. It allows more RPM potential than that of the hydraulic tappet since there are no worries about the inability of the lifter to "bleed down." Solid lifters do, however require lash or clearance to allow for part expansion as the engine heats up.

Mechanical Roller Tappet

The mechanical (solid) roller tappet allows for the most aggressive lobe designs. Roller tappets allow faster, "steeper" opening and closing ramps. This allows the cam to produce more lift for a given duration. They are not limited to a particular lifter diameter to obtain higher cam lifts. They also contain a roller that reduces friction between cam and followers. Roller cams require the use of higher valve spring forces making high engine speeds (over 10,000 RPM's) possible.

Hydraulic Roller Tappet

The hydraulic roller tappet camshaft can provide the best of both worlds. Diesel engines and some motor cycle engines have used this design for many years. They provide most of the virtues of a solid mechanical roller tappet while providing the benefits of quiet operation and ease of valve lash setting.

This type of design still has the limitations of an oil bleed-off control type follower. If your application requires high RPM potential you should use a solid roller tappet design.

FLAT TAPPET OR ROLLER?

Manufacturers and racers have used flat tappet camshaft systems over the years with great success. However, manufacturers and racers favor roller tappet cams (when rules permit their use) because roller cam designs have distinct advantages over flat tappet designs:

Friction

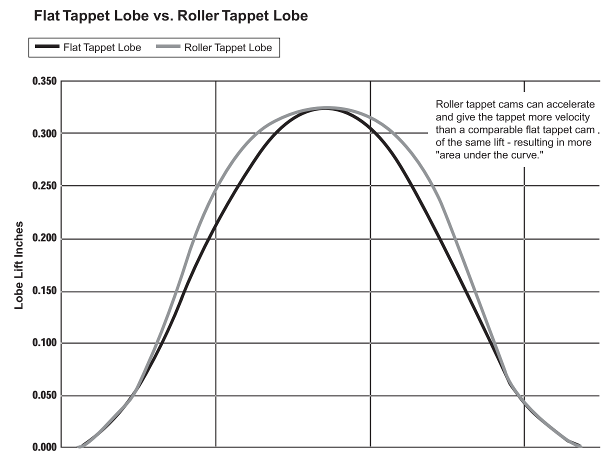
Sliding frictional forces are higher than rolling frictional forces. Therefore, a roller cam takes less horsepower to turn and generally does not wear out as quickly. An added benefit is that roller tappets do not require replacement when changing cams. And, if "pop-up" solid roller tappets are used (such as P/N 72840), the camshaft can be swapped without removing the intake manifold.

Profile

If a cam profile has more "area under the curve," it has the potential to make more power. Roller profiles can be more "aggressive" and accelerate the tappet more than a flat tappet profile.

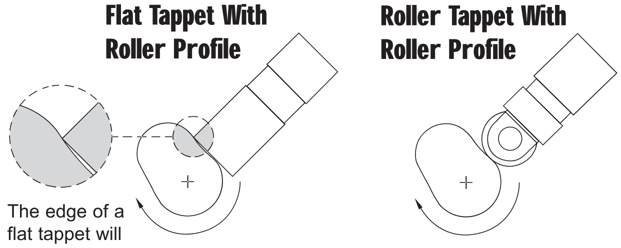
Flat tappet profiles can only be shaped up to the point where the tappet "digs into" the profile. Roller tappet profiles are not limited by this condition-so much that even "inverted radius" profiles are possible.

This benefits engine performance in two ways: more tappet lift can be achieved without the added duration that would normally be required to "ramp up" a flat tappet to the added lift-making the lift curve more "pointy"; the lift curve can be made "broader" without increasing lift. Of course, both of these benefits can be combined to create a profile that can easily outperform flat tappet cams.



Flat Tappet With Roller Profile

Roller Tappet With Roller Profile



The edge of a flat tappet will "dig into" the ramp of an aggressive roller tappet profile

Cost

Unfortunately, roller camshaft systems cost more than a flat tappet cam and lifters. Much of the added cost is due to the lifters. However, roller tappets can be re-used, where as flat tappets cannot not be re-used. If you tear down your engines frequently, the rollers can be used over and over again provided they are not damaged or show signs of wear.